Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0001

Darcy L. Endo-Omoto
Vice President
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March 18, 2009

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2009 MAR 18 P 4: 22
PUBLIC UTILITIES COMMISSION

The Honorable Chairman and Members of the
Hawaii Public Utilities Commission
Kekuanaoa Building, First Floor
465 South King Street
Honolulu, Hawaii 96813

Dear Commissioners:

Subject: Docket No. 2008-0273
HECO Companies' Responses to the Commission's Information Requests

The Commission submitted Information Requests ("IRs") prepared by the Commission's consultant, the National Regulatory Research Institute, by letter dated March 2, 2009 in the subject proceeding.

Enclosed are the Hawaiian Electric Companies' responses to PUC IRs 1 to 3, 5 to 31, and 33 to 35.[1] Responses to the remaining IRs will be submitted to the Commission shortly.

Sincerely,

Darcy L. Endo-Omoto

Enclosures

cc: Service List

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[1] The "Hawaiian Electric Companies" are Hawaiian Electric Company, Inc., Hawaii Electric Light Company, Inc., and Maui Electric Company, Limited.

SERVICE LIST
(Docket No. 2008-0273)

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PUBLIC UTILITIES COMMISSION

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PUC-IR-1

For each island, with the current levels of demand, transmission, and supply resources, what is the maximum amount of total and additional intermittent resources that can be accommodated without compromising reliability?

Response:

The attributes of variable generation that impact the reliability of the power system are:

- Variability : the amount of change according to the availability of the primary energy source (wind, sunlight and water motion) resulting in increased fluctuations in the plant output on all time scales
- Uncertainty: the ability to forecast the magnitude and timing of variable generation

Reliable system operation requires balancing of supply and demand at every moment in time, in accordance with prevailing operating criteria. The measure of successful power balancing on the Hawaii power systems is the system frequency. There is a certain amount of variability and uncertainty in system demand and to a lesser extent with conventional generation. However, large scale integration of variable (intermittent) generation significantly alters familiar patterns for the system. Even for larger plants which can have enhanced control features (such as ramp control, or curtailment control) the variable resources are not fully dispatchable, and therefore require use of other controllable or dispatchable resources to balance the supply and demand. Thus, as intermittent, variable generation adds to the power imbalance, there can be a corresponding impact on reliability through the increased balancing error that will result from the addition. The practical question is the degree to which reliability has become affected, and what amount of reliability impact is acceptable in order to accommodate the additional intermittent resources. In addition to creating imbalances on the power system, if operational practices allow the variable generation to displace dispatchable generators from the system, complications increase due to the loss of the response capabilities from the dispatchable generator.

In summary, the amount of variable generation that can be accepted on a power system will depend on various factors such as:

- the characteristics of the variable generation such as rate of change, correlation with other resources, degree of possible change in a given time period, predictability of output, control capabilities, etc.
- the characteristics of the other controllable or dispatchable resources on the system such as available ramp rate, frequency response, minimum load, startup time, etc.
- the minimum number of conventional generators which are necessary to provide reliability operation of the power system: as necessary to survive reasonably probable faults and disturbances, ability to regulate voltages, perform load balancing and frequency control
- operational configuration to mitigate reliability impacts and their costs, for example, the inclusion of increased reserves (minimizing displacement of dispatchable units)
- evaluation of possible technical solutions and their costs such as supplemental controls on the variable generation, modification of the dispatchable generation, infrastructure modifications
- Establishing minimum reliability criteria to be maintained on the power system

Therefore, for each of the HECO Companies' island systems, there is no single, set maximum amount of total (and additions over current) levels of intermittent resources that can be accommodated without compromising reliability. Rather, resource planning should focus on identifying the means to reduce the impact to reliability with the addition of a high percentage of intermittent generation on an island system. In order to minimize the impact, utility engineers and planners along with owners and developers of intermittent generation must focus on minimizing the variability in output from these generators and minimize the unpredictability in output from these generators. If variability and unpredictability can be reduced, then all other things being equal, an island system should be able to reduce the impact to reliability with a certain amount of intermittent generation (or possibly increase the amount of intermittent generation while minimizing the reliability reduction created).

PUC-IR-2

List and describe all major transmission and distribution system upgrades as well as new dispatchable generation and storage resources that are under construction or planned and what year they are expected to commence operation. Some of these may have been included in HECO and the Consumer Advocate's response to HDA/HECO-IR-5, although this question seeks the specific project characteristics and their in-service dates.

Response:

The following is a list of major transmission and distribution system upgrades, as new dispatchable generation and storage resources, as well as other projects or initiatives and studies under way or planned. This list includes a general description of the projects and when they are expected to commence operation or other be complete.:

- Hawaiian Electric has currently under construction a 110 MW simple-cycle combustion turbine on Oahu ("CT-1"). In addition to providing needed firm capacity to address an existing shortfall in reserve capacity, this unit will be able to start more quickly than existing steam generation cycling units and change its output level more quickly (higher ramping capability). CT-1 is anticipated to commence operation in 2009.

- The response to TPL-IR-11 describes specifics for items referenced by HDA/HECO-IR-5 pertaining to HELCO. As is indicated in this response, several of the referenced items have been completed. Projects being conducted in the near-term, are:

    - Wind forecasting research to examine the potential for targeted event prediction through use of supplemental meteorological data. The initial phase, which will investigate the feasibility of this approach, will be completed by fourth quarter

2009. This work is discussed further in the response to TPL-IR-11.

- o A system study performed by the systems engineering firm, Electric Power Systems Inc. ; to evaluate the impact of distributed PV generation on the HELCO underfrequency load shed scheme, by contractor EPS, to be completed in the first half of 2009. This work is discussed further in the response to TPL-IR-11.

- o An in-house project to use remotely monitored small PV arrays installed at substations across the island, to assess on a per unit basis the solar intensity at each substation, to obtain field data to better understand the correlation or diversity of PV output across geographic areas on the system. The anticipated completion date for this project is in the fourth quarter of 2009.

- The following HELCO projects have been proposed as research projects for possible funding, by various entities, but are not yet approved and finalized (project dates will be within 12 months of acquiring funding):

  - o Technical solutions to address the large phase-angle difference that prevents reclosure of critical cross-island transmission lines after fault-clearing. This constraint requires curtailment of the Pakini Nui wind plant.

  - o Collection of phasor measurements form the electronic relays to allow the system operator, in real-time, to monitor the stability of the power system and adjust power system operation as necessary if the measurement indicate risk of system instability

- o Use of supplemental tie-line controls via a storage device, to smooth variable generation input to the HELCO system. This problem has created a large ambient frequency error which required increasing the no-control dead band on frequency error, such that it approaches alarmable levels in off-peak conditions.

- As part of the "Big Wind" Implementation Studies, Hawaiian Electric is undertaking analytical and empirical studies to identify, among many things, transmission system upgrades, new and upgraded generation (and needed attributes), and possibly needed storage required by the Oahu system in order to integrate variable generation from "grandfathered" projects, Oahu's RE RFP, and the Big Wind projects and reliably tie power from these projects to the Oahu grid. Empirical studies at HECO's steam-electric generating units are characterizing and improving the dynamic responses [to disturbances on the grid] and dispatchable ramp rates. Because these studies are still underway, specific attributes of new generation and the transmission system upgraded and timing of both have not been identified. Results from these studies are expected in the first quarter of 2010.

- Also part of the "Big Wind" Implementation Studies, Hawaiian Electric is performing an EMS Evaluation Study to determine how we can prepare our EMS/AGC system and our operating practices for the Big Wind projects. Time for completion is July 2009

- Maui Wind Integration Study - HNEI/GE/HECO/MECO completed the development of a system model for Maui in 2008. The Maui system was modeled using GE's MAPS and PSLF software. Using the model developed in 2008, a wind integration study will is being conducted to analysis the integration of additional wind farms, including the character and magnitude of operating constraints, wind farm performance requirements and remediation. Completion date of the study is scheduled for 2009.

- Maui Smart Grid Project - Hawaii Natural Energy Institute submitted a proposal to the US Department of Energy and National Energy Technology Laboratory in partnership with General Electric, Sentech, HECO, MECO and First Wind for a Smart Grid Project. Objectives for the project are to focus on a solution that deploys and aggregates distributed generation, energy storage, and demand response technologies on a distribution system. Also, provide for management of short-timescale intermittency from resources elsewhere in the grid, such as wind energy, solar energy or load intermittency. Expected completion date for the Smart Grid Project is 2012.

PUC-IR-3

What would the answer to Question 1 above be if the upgrades in Question 2 were completed, absent changes in energy demand or other factors? Provide the answer for each year in which the upgrades enter service.

Response:

A determination of how many more megawatts of intermittent generation can be reliably added to an island system with the addition of new major transmission, distribution, new generation and storage systems is difficult to determine by a simple arithmetic calculation. As mentioned in response to PUC-IR-1 and PUC-IR-5, determining specific thresholds for the general category of variable, intermittent generation for each of the Hawaiian Electric Company's island systems, and the total (or incremental in the case of this IR) levels of intermittent resources that can be accommodated without compromising reliability will depend on the characteristics of the intermittent generation, including the variability and the unpredictability in output from these generators as well as their ride-through capabilities and their ability to provide any type of frequency or voltage regulation.

The response to PUC-IR-5 explains that the location of proposed generation and size of the project, or the aggregate impact of smaller projects, will determine whether or not transmission will be a constraint to a particular project, and describes existing congestion areas on the HECO and HELCO systems.

PUC-IR-5 and PUC-IR-6 describe the manner in which the amount of dispatchable resources and ancillary services are a consideration in the amount of variable generation that each system can accommodate. The characteristics of dispatchable generation are a very important consideration, and flexible generation provides operators with additional tools that can be useful to mitigate the impacts of variable generation on balancing and frequency control. For example, the addition of CT-1 on the Oahu system will increase the system's total ramping capability. It will also increase the amount of generation that can be started in the minutes timeframe. Collectively, these attributes will increase the grid's ability to deal with greater variability and greater unpredictability in intermittent generation. The amount of additional intermittent generation that can be reliably added to the Oahu system in megawatts as a result of the addition of CT-1 is difficult to determine, as this will depend on the level of variability and unpredictability of the intermittent generator or generators under consideration.

Studies which accomplish the following can be of assistance in any effort to effectively integrate a very significant amount of intermittent generation on the HECO system:

1. considers the specific levels of variability and unpredictability expected from the grandfathered projects, projects under evaluation in the RE RFP, and from the Big Wind projects;
2. identifies ways to mitigate the variability and unpredictability of these resources through consideration of the effectiveness of storage or other sustained ramp mitigation equipment that can be added to the intermittent projects;
3. look into the ability to provide new wind forecasting models, that are not available today, that may be able to reduce the unpredictability for each project (primarily for wind farms) by providing a warning for sustained ramping events. These ramping events at the wind plants have been a major issue for HELCO and MECO and are of increasing importance

to mainland utilities as their levels of penetration of wind power increases towards that already online at HELCO and MECO;

4. identifies modifications to existing HECO generating units that can be performed to improve their ramping and cycling capability;
5. identifies modifications to the EMS/AGC system to improve system response, and
6. identifies beneficial changes to operating practices.

In short, undertaking a comprehensive study such as the Big Wind Implementation Studies and employing a holistic approach to identify a combination of solutions to solve a defined scenario of new intermittent generation integration can yield more meaningful and cost effective solutions.

Due to these complexities in determining overall goals and anticipating system impacts, the proposed FiT targets smaller projects which on an individual basis are less likely to create significant grid issues. services. The impacts on the system can be evaluated over time and adjusted as necessary to improve reliability or to take advantage of newly implemented operational tools. Larger projects would be procured on the basis of a competitive bid. The impacts of the proposed competitively bid project would be analyzed in a system impact study and potential mitigation measures identified in advance, which could include requirements in the project design or modifications of utility resources and equipments. Larger projects are more likely to be able to provide grid supporting ancillary services, since they use more sophisticated technologies that can be more economically included in large scale equipment than equipment small enough to be installed via standard interconnection requirements.

PUC-IR-5

For each island, please describe to what extent any current or likely potential reliability constraints on the integration of intermittent renewable energy resources are driven by the amount of available intra-island transmission capacity or by the amount of dispatchable resources and ancillary services.

Response:

Amount of Intra-island Transmission

Reliability constraints due to transmission capacity are not dependent upon the behavior of generating resources, (i.e.; variable, intermittent or dispatchable). These constraints are the result of the power flows on the system, and therefore are the result of the amount or size of generation additions and the location of the generation additions. The larger the generation addition, the more likely it will have a significant impact on the transmission system. This is one reason to target small generating resources with the proposed FiT, as small installations are less likely to significantly affect the transmission system and so do not require the higher level of analysis associated with larger projects. Larger installations require a system impact study to ensure that the existing transmission (and distribution, if applicable) infrastructure can support the proposed project. Multiple small generation projects can, if clustered in a location, also result in significant alteration of power flows and could result in a transmission constraint. Location targeting and aggregate system targets may help address the issue.

There are some congestion areas on the HECO and HELCO systems, which could be constraints for renewable energy additions requiring additional infrastructure to resolve.

On the HECO system, most of the generation is sited on the west side of the transmission system and the majority of the load is located on the east side of the transmission system. The eastern end of the transmission system consists of two essentially radial spurs each fed by three transmission circuits. During maintenance outages, these circuits can be at risk of overloading especially as load continues to grow in the area east of Iwilei in the south east and north and east of Kaneohe in the north east. If additional energy resources are added to the system west of those areas, these potential overloads will persist and worsen to the point were new transmission circuits will be needed.

The intra-island transmission system on the MECO grid has generally not been a limiting factor for intermittent renewable energy resources.

On the HELCO system, strong East-West power flows result in potential overload. The east to west flow of power is such that generation must be run on the west side to prevent transmission overloads following an outage on certain transmission lines and it is difficult to reclose some of the cross-island ties if they open for faults, due to the large phase angle difference. Siting additional generation outside of the western load area will likely worsen these conditions.

Amount of Dispatchable Resources and Ancillary Services

Variable generation creates various technical issues, which may result in constraints, as described in the response to PUC-IR-6. The potential reliability constraints created by variable, intermittent additions are highly dependent on the size and technical characteristics of the additions, such as project size, degree of variability, correlation in variability with other variable resources on the system, the degree to which they are able to participate in frequency and voltage regulation, and total amount of variable project additions anticipated on the system. Due to these complexities, the proposed FiT targets smaller projects which on an individual basis, are unlikely to create significant issues, but are also less likely to provide much in the way of ancillary services; and provides for system targets, to allow aggregate system impacts to be evaluated. For larger projects, the impacts of the proposed project would be analyzed in a system impact study and potential mitigation measures identified which could include changes to the project design or modifications of the utility resources and equipment. Larger projects are also more likely to be able to provide grid supporting ancillary services since they use more sophisticated technologies that can be more economically included in large scale equipment than equipment small enough to be installed via standard interconnection requirements.

For systems with high penetration of variable, intermittent resources, such as HELCO and MECO, the current reliability constraint affected by dispatchable generation and ancillary services is the impact of the variable generation on system balancing and frequency control and contribution to excess energy conditions. At issue is not so much the *amount* of dispatchable generation, but rather the *characteristic*s of both the dispatchable and variable generation resources. Important to managing the uncertainty and variability of intermittent generation are those characteristics described as flexibility, such as: ramp rate, frequency response, rate of change of frequency response, dispatchable range, minimum load requirements, cycling capability, and startup time. Further discussion of the current constraints and impact of dispatchable resources on various constraints related to intermittent generation is provided in the response to PUC-IR-6.

The degree to which reliability constraints will restrict the integration of intermittent renewable energy will depend on the characteristics (starting time, ramp rate, inertia, etc) of the dispatchable resources and the characteristics (variability and grid support) of the future intermittent renewable energy resources. Similar to the experiences of today, the characteristics of dispatchable generation will be as important as the amount of dispatchable generation resources on the system.

PUC-IR-6

On islands, such as the Big Island, that feature a high penetration of intermittent resources, to what extent would the availability of additional dispatchable and curtailable resources improve reliability and/or facilitate the incorporation of additional intermittent resources?

Response:

There are various technical issues that should be considered in the incorporation of additional intermittent or variable generation resources. Transmission constraints are not considered below as such constraints are the result of location on the power system, and the effect on power flows, rather than the result of the variability.

1. **Risk to system caused by the aggregate loss of distributed generation connected according to minimal IEEE 1547 guidelines during disturbances and faults (common for distributed PV system).**

2. **Displacement of generation performing critical grid services.**

3. **Adding to existing variability**

4. **Displacement of existing renewable energy sources (excess energy, curtailments).**

These are discussed below in greater detail to consider if dispatchable or curtailable resources would address the problem.

1. **Risk to system caused by the aggregate loss of distributed generation connected according to minimal IEEE 1547 guidelines during disturbances and faults.**

   Problem Description. This issue is not really directly related to the intermittency or variability of generation resources, but rather, it is the result of the technical standards presently in place for most of the intermittent, variable generation connected to the distribution systems. For example, PV under net energy metering and small projects proposed for the FiT that are less than 30 kW have been and are expected to be connected using the IEEE 1547 guidelines that set a frequency trip point for those systems at 59.3 Hz. Larger systems can and have used the same frequency setting. Generation connected according to this setting is more likely to trip due to the frequency deviations caused by the existing large wind plants on the HELCO system.

   The IEEE 1547 guidelines provide trip settings for the DG to minimize risk of islanding, while also minimizing the investment required for more sophisticated anti-islanding schemes. A high penetration of DG units using the same trip settings will result in simultaneous loss of DG over the entire system for off-normal frequencies due to generation/load imbalances, driving the system frequency even lower. Such imbalances are felt system-wide as the result of loss of generation, loss of transmission, wind down-ramps, or system faults. Nuisance trips will also occur for off-normal voltages that occur during transmission system faults and contingencies; in such cases the effect can be quite far from the fault but more localized than the frequency effect. The aggregate loss of large amounts of distributed generation creates additional imbalance during frequency dips due to wind ramps or generator trips. This will result in an additional loss of customers due to load-shedding than what would have occurred historically for the same event. If the penetration of this type of the generation gets too large, the amount of additional generation lost following a system disturbance could get large enough to render the existing underfrequency load-shed scheme ineffective at correcting the load/generation imbalance and could result in system failure.

Impact of Additional Dispatchable or Curtailable Generation

The issue could be addressed by carrying additional spinning reserve, which could come from existing dispatchable units for the case of HELCO. At this time, the HELCO system has a number of dispatchable units that are typically left offline, used only for emergencies. Generation in the intermediate position on the commitment order is often displaced from the system to accommodate wind and hydroelectric generation, and online reserves are kept as low as possible as a cost-savings measure. If existing or new dispatchable resources are kept online, providing additional spinning reserve and system inertia, The frequency response of these resources will help offset the potential loss of generation due to nuisance trips of the DG, and reduce the underfrequency load shedding or at least make the outages shorter if the rate of change exceeds the ability of the reserve units to respond. To keep reliability at the same levels as prior to the connection of DG under these guidelines, reserves would need to be approximately equal to the amount of energy being produced by the DG. At this time, the system operator does not have visibility or control of these DG resources so the reserve would need to be estimated. However, carrying the extra reserve would have secondary effects of adding to the excess energy problems on the HELCO system, and increasing the fuel-costs for conventional generation.

Other solutions, which could be more effective in preserving reliability than additional reserves, are limiting aggregate amount of generation connected according to IEEE 1547 standards or requiring expanded ride-through requirements similar to conventional generation for DG.

2. Displacement of generation performing critical grid services.

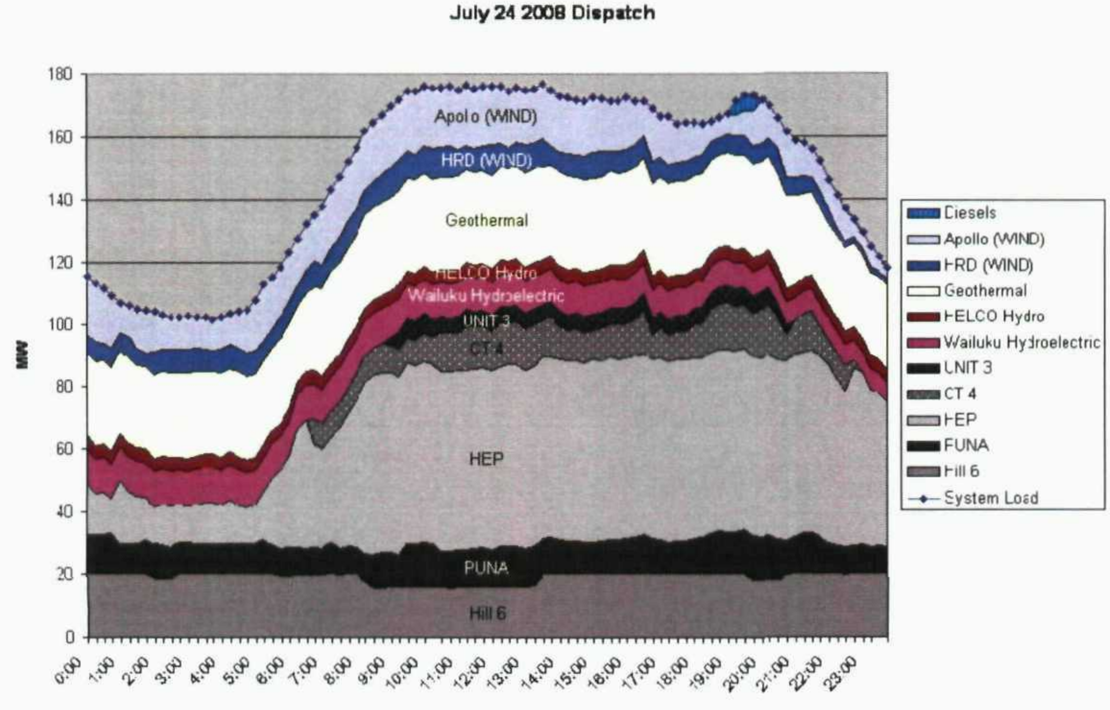


Figure 1

Problem Description: A certain amount of dispatchable generation is necessary on the system to ensure that firm capacity is available to serve the load, provide system stability, perform load following and frequency regulation. With the variability from the two wind plants on the HELCO system, it is especially important that sufficient ramping capability be maintained on these dispatchable units to offset the ramps from the wind plants. Certain locations on the HELCO system also require generation for the purpose of voltage regulation and balancing load flows on the transmission system. A dynamic analysis has shown that the HELCO steam units provide necessary governor dynamic response to prevent undamped frequency oscillations which can be avoided by an operational policy of having no fewer than two steam units be online at any given time. This requirement necessitates maintenance of four steam units with the necessary characteristics as shown through analysis, to serve as back-up resources in the event the Hill or Puna generators trip off the system, especially critical during overhaul periods of one of the steam units. During periods of overhaul of one of the must-run units, the off-peak regulation is reduced by the reserve contribution of the outaged unit. In Figure 1 above, only the units shown in black or gray tones provide frequency regulation and load following. During overhaul of one of these units, this leaves three units on dispatch control during off-peak conditions and four or five during on-peak conditions. With this minimum amount of generation, the ability of the generation to compensate for imbalances created by changes in wind plant output and load demand are exceeded, resulting in numerous frequency deviations. In addition to the minimum loading for stable operation of these units, a minimum reserve up and down, dispatchable by AGC control, must be maintained to ensure system responsiveness for typical sub-hourly imbalances

Impact of Additional Dispatchable or Curtailable Generation
This problem is that a minimum number of units providing critical grid services must remain online at all times on the power system to provide a stable power system. These units cannot be displaced by variable intermittent generation resources that do not provide those services; and this provides an upper limit on the feasible amount of variable generation on the power system. Adding additional resources is not relevant to this particular problem. Variable generation may need to be curtailed in order to accommodate the units. For projects greater than a certain size, curtailment capability may be economically, administratively and technically feasible; but may be uneconomic for small projects.

3. Adding to existing variability

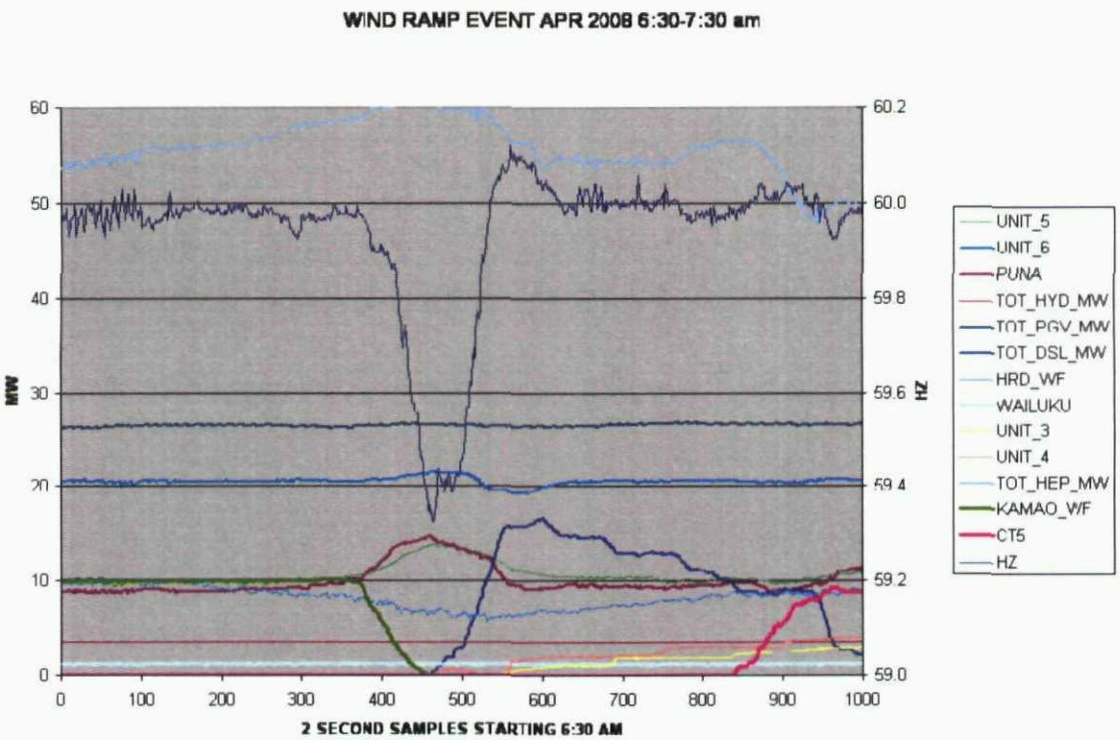


Figure 2

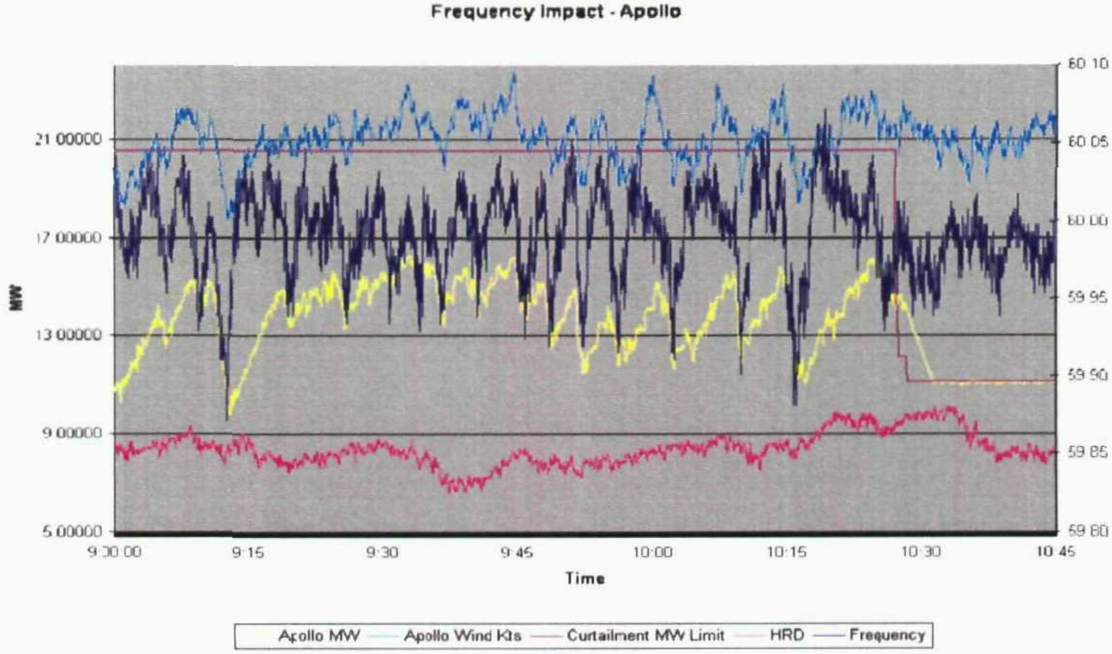


Figure 3

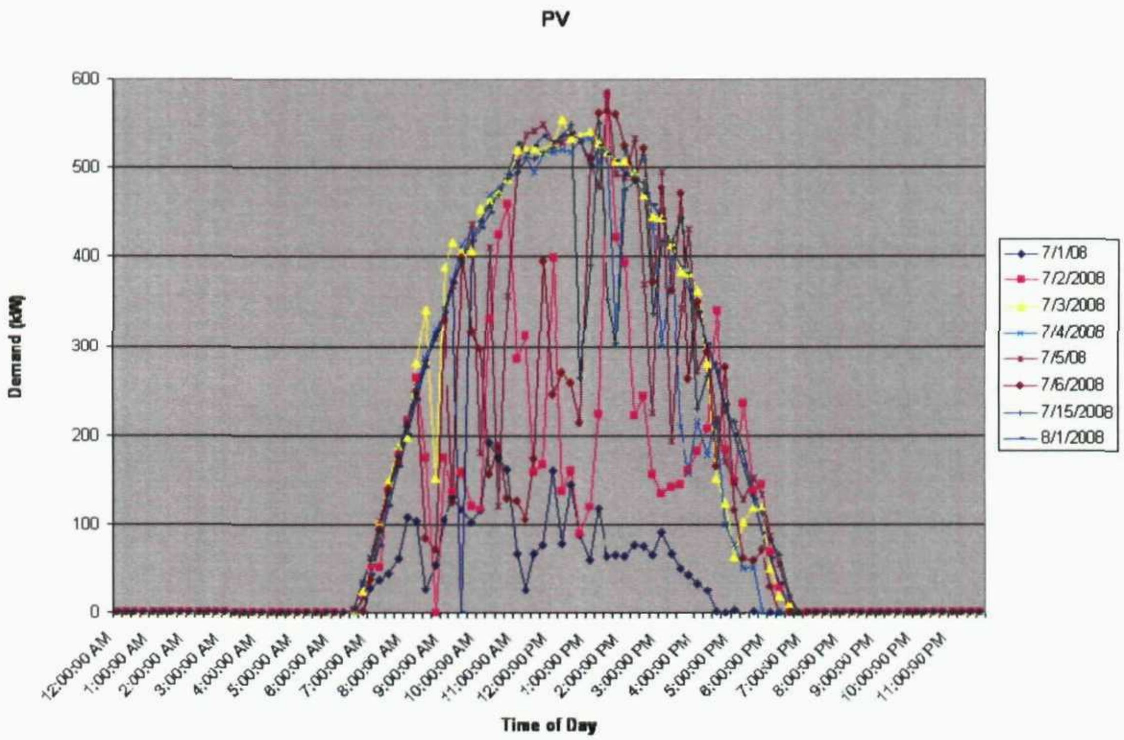


Figure 4

Problem Description: Renewable resources such as wind and solar depend on a variable energy source, resulting in variable production. As an island system, every aggregate change in production from the variable generation plus the aggregate change in system demand on the system requires a commensurate change in the online regulating dispatchable generators to maintain system frequency.

Impact of Additional Dispatchable or Curtailable Generation

The HELCO system does have some flexible, dispatchable resources in the form of fast-starting diesel units. Some of the must-run units, such as the existing geothermal facility, are not dispatchable and cannot contribute to system balancing. HELCO's system operator has been unable to completely mitigate the frequency impact resulting from the existing variability introduced with the wind plants with the existing resources. The impact of variable generation occurs in different time frames, and the ability of dispatchable generation to assist differs for the time frame. Figure 2 shows a ramp event which happens in the time frame of minutes. For ramp events such as shown in this case, having additional dispatchable generation online in the form of regulating reserves could have reduced the frequency drop, assuming the rate-of-change did not exceed the ramping capability of the reserves. At the start of this ramp event, the system operator had larger online reserves than typical, but the impact of the wind ramp was exacerbated by the fact that it occurred at the time of the morning load ramp so that even with the reserves, the regulating units could not compensate for the loss of wind power (in aggregate). The drawbacks of carrying mandatory reserves are increased costs for fuel and variable maintenance, and increased minimum load on the dispatchable generation which adds to the excess energy problem. The ramp rate of the units is also important, and if the variable generation exceeds the available ramping capability, the frequency will decline even if there is sufficient capacity reserve.

In the ramp event illustrated in figure 2, the operator halted the frequency decline by bringing on fast-start diesels. Additional fast-start, dispatchable generation are important resources for the operator to mitigate sudden imbalances such as this one, without requiring the reserves to remain online; however this does not eliminate the possibility of underfrequency load shed events since the operator cannot distinguish between a sustained ramp from a momentary dip in wind when the decline in output first starts. The drop in frequency provides the indication that there is a shortfall. The operator may be too late in starting the standby generation to avoid a decline to 59 Hz and underfrequency load-shed. Thus additional dispatchable fast-starting units such as the small diesels are useful resources in mitigating frequency declines due to loss of intermittent generation, while they do not entirely remove the risk of short outages due to the inability to accurately predict these events in advance. Having the fast-start capabilities provides an alternative to online reserves; the fast-start units provide offline reserves that are able to start quick enough to replace intermittent resources that are being lost during a sustained ramp down in the energy resource, providing a means is available to give the system operator sufficient advanced indication of the ramp event to enable the units being brought-online in time to avoid excessive imbalance. The use of off-line resources in place of online reserves reduces fuel costs for carrying reserves, but is unlikely to result in the same reliability due to the need for startup time and the lack of advance notice available to system operators. As such, a balance of online and off-line resources is likely the optimal approach to mitigate both the risk and cost associated with the variability and unpredictability of intermittent energy resources.

In order to know how much reserves are necessary for potential loss of intermittent generation in a ramp event, the system operator will need data about how much intermittent production is on the system. At this time real-time energy production values are provided to the system operator for transmission-side variable resources (wind plants and hydroelectric facilities), but are not available for the distributed PV systems.
The ability to curtail variable resources does not address frequency decline due to down-ramps. However, the ability to curtail variable resources is a good tool for the operator to manage up-ramps (and high frequency). The output of the variable resources could be curtailed until the dispatchable units can reduce output enough to balance generation and demand.

Figure 3 shows the frequency impact from the HELCO wind plants in the sub-minute time frame. The balancing in this time frame is managed by the local droop response of those units with frequency response. This variability occurs more quickly than the time frame that can be managed by load-following and supplemental frequency control through the centralized control system (automatic generation control). In fact in order to avoid exacerbating frequency error by incorrect control actions (over-control), the dead band on frequency error for supplemental frequency control had to be increased, allowing greater frequency error before corrective actions are taken. Additional dispatchable generation would assist in countering the frequency error if that generation is kept online, and reserve capacity is kept on all of the units to allow increase and decrease through droop. HELCO has modified the dispatch limits for units under AGC control to prevent being dispatched at upper and lower limit of operation; in that manner forcing reserve capacity to be carried on many units. The drawback of having more units online is the same as adding reserves; increased costs and increased minimum load on those units which contributes to excess energy.

Curtailment of the intermittent generator can help with this issue. As shown in figure 3, when the variable plant was curtailed by the system operator, the frequency stabilized as it resulted in a smoother output from that facility.

It is known that the rates of change of PV can exceed that of wind, but not well understood how correlated PV fluctuations are over an extended area. Figure 4 illustrates the variation in output from a large commercial PV in the Kona area. We know that adding variability through PV installations will increase variability, but how significant this will be cannot be quantified without additional data regarding the correlation of various sites and the distribution on the HELCO system. If strongly correlated, PV may produce ramp events similar to the wind ramp. There is also potential for the PV to be affected by similar phenomenon as the wind plants and thus have correlated decreases or increases in output with wind events.

4. Displacement of existing renewable energy sources (excess energy, curtailments).

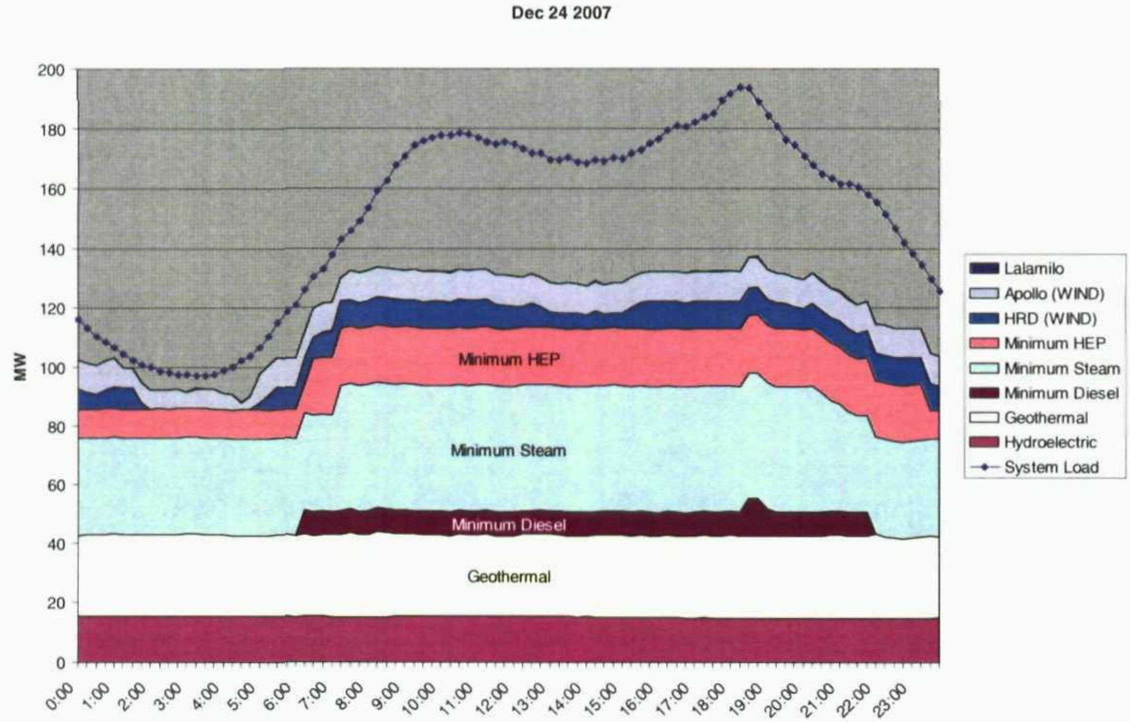


Figure 5

Problem Description:. At present, the renewable energy is often curtailed during off-peak conditions as the amount of energy being produced exceeds the capability of the system to accept the energy with consideration of the minimum dispatch on must-run units.

Impact of Additional Dispatchable or Curtailable Generation
Adding more dispatchable units has no positive effect on this issue, as it is a problem with too much generation relative to demand. Variable generation additions which are not telemetered, such as small PV on the distribution system, can contribute to excess energy as they reduce load ahead of transmission side resources because HELCO does not have control of those generators. Adding visibility and curtailment control as a requirement for future variable generation additions can help as it provides a means to reduce those resources to make room for the minimum load of the must-run units under periods where supply exceeds demand.

PUC-IR-7

What is the anticipated completion date of each section of undersea cable system between islands described in the HCEI Agreement?

Response:

Exhibit A of the HCEI agreement shows a target goal of 2015 for the 400MW of wind power from Molokai and/or Lanai. The cable system between those islands and Oahu would need to be in place at or before 2015 to meet that goal and efforts are underway to meet that goal. The timing of an undersea cable system between other islands has not yet been determined.

PUC-IR-8

How would the proposed undersea cable systems facilitate additional renewable energy integration in each island?

<u>Response:</u>

Since over three-quarters of the combined power requirement of the HECO, HELCO, and MECO systems is on Oahu and the majority of the developable renewable energy resources are located on the other islands, the undersea cable systems, and the associated on island transmission additions, would enable the transmission of renewable energy from the resources on other islands to the load on Oahu. The HELCO and MECO systems currently experience times when excess energy requires the curtailment of wind energy resources on those islands. See the response to PUC-IR-6 for more information on the excess energy issue. Large scale renewable energy integration cannot take place until the resources on the other islands can be connected to the HECO load.

PUC-IR-9

How many additional MWs of intermittent resources could likely be integrated into each island with the undersea cable system completed?

Response:

In conjunction with other resources such as additions and upgrades to the Oahu T&D facilities, modifications to existing Oahu generating units, new quick starting and fast ramping generating units, modifications and re-tuning of the AGC/EMS system, and possible development of wind forecasting models, the objective of the undersea cable system between Oahu, Lanai and Molokai is to develop the capability to reliably integrate a total of up to 400 MW of wind power located on Lanai and Molokai. Subsequent analysis is planned to evaluate the capability of the combined Oahu/Lanai/Molokai grid systems to interconnect to Maui in conjunction with the possible development and bulk transmission of renewable energy between these islands.

PUC-IR-10

Would the undersea cable system enable the FiT to include larger systems than those proposed by HECO and the Consumer Advocate? Please explain why or why not.

Response:

The undersea cable system alone will not enable the integration of larger FIT-acquired intermittent generation systems.

The undersea cable systems are envisioned to interconnect large wind farms located on Lanai and Molokai with the Oahu 138kV transmission system. The undersea cable system, at this stage of the implementation studies, are not envisioned to interconnect with existing Lanai and Molokai grid systems because of the potential of either wind farm to deliver far more power (up to two orders of magnitude greater) than those island's loads. Potential for such a severe mismatch of power, even for a few hundredths of a second, can create extremely dangerous conditions and pose serious safety risks to residents of both islands. Thus, an undersea cable system is not anticipated to have any impact, either positively or negatively, on the Lanai and Molokai grids or the ability of those grids to integrate FIT-acquired resources.

In the case of the island of Oahu, the undersea cable system alone will not enable the integration of larger FIT-acquired intermittent generation systems for two reasons:

1. Challenges of integrating larger FIT-acquired systems exist on the distribution systems where the majority (if not all) of these resources are likely to be interconnected. 12kVdistribution circuits on Oahu (with the exception of the downtown network) are of a radial design with backup circuits to transfer load, which is typical of the electric utility

industry. The addition of larger (or the aggregation of many smaller) generating units on a distribution circuit, such as those acquired through a FIT program, can create challenges in delivering tariff specified voltages to customer loads along the distribution circuit. In extreme cases, such generators may result in safety issues for both customers served by the circuit and utility workers maintaining equipment. Mitigation of these effects and risks can be accomplished through circuit specific and generator specific equipment and operational restrictions, such as use of dynamic transfer trip relay schemes or curtailment control interfaces and the contractual ability to curtail generator output during certain conditions, such as when the distribution circuit is lightly loaded or when the distribution circuit (and the generator) is operating in an non-normal state via its backup circuit. However, such specific solutions to address larger distribution interconnected systems can be contrary to the generally recognized benefits and objectives of a FIT program – a streamlined process with simpler standards for interconnection and simpler, pre-established commercial and operating terms. The Company believes that integrating larger systems and addressing the voltage and safety issues that may arise for larger systems is better addressed through case-by-case technical analyses and tailored contractual terms. Because the undersea cable system will be interconnected to the Oahu grid at the 138kV transmission system, it is not envisioned to have any impact on these aforementioned distribution system interconnection challenges.

2. Because FIT systems are likely to be intermittent generation themselves, larger FIT-acquired systems may increase the level of variability and unpredictability of power that firm generators on Oahu must offset. The intermittent power exported from Lanai and

Molokai to the Oahu grid via the undersea cable system will further increase the level of variability and unpredictability of power that the firm generators must offset.

PUC-IR-11

Please describe the anticipated effects of time-of-use (TOU) rates, robust demand response programs, and other initiatives facilitated by advanced metering infrastructure (AMI) on system reliability.

Response:

Time-of-use ("TOU") rates, demand response ("DR"), and other initiatives which could be facilitated by an advanced metering infrastructure ("AMI") taken as a whole may have a positive impact on system reliability. There are costs incurred to implement these technologies, and some of these concepts are still conceptual or under development, not presently under wide-scale implementation, and/or have not yet been fully evaluated in the market. The costs and risks would need to be evaluated against the potential benefits of developing these programs.

TOU rates are designed to motivate customer usage to increase during periods of low demand and lower production cost and decrease during periods of high demand and high production cost. TOU rates by themselves are unlikely to have a direct impact on system reliability. However, if broad adoption of TOU rates can significantly increase off-peak demand and raise minimum loads, it may indirectly improve the reliability of an electric system with high levels of off-peak fixed dispatch and intermittent generation by increasing the loading levels or otherwise allowing for more running dispatchable units.

DR programs can either displace portions of or supplement online generation reserves (spinning reserves on Oahu, operating reserves on Maui and Hawaii Island). The addition of DR to provide supplemental online reserves (in the form of "negative online generation") can have a positive impact on system reliability to loads not participating in a DR program by allowing the system operator more options to maintain generation and load balance. Similar to efforts undertaken in ERCOT, the Hawaiian Electric Companies could use DR to reduce load at times to avoid underfrequency load-shedding when additional online or fast starting dispatchable generation is unavailable and when intermittent generation on the system is experiencing a sustained ramp-down event. However, unlike ERCOT where the ramping events occur in a multi-hour time frame, the ramp events on the HELCO/MECO/HECO system can occur in a matter of minutes. Thus the ability of DR to balance the system in time to avoid underfrequency load-shedding resulting from sustained variable generation ramps would be dependent upon the time frame in which it can be deployed.

Though only at the conceptual stage today, other AMI enabled initiatives such as the potential for load shedding schemes at the customer meter may provide a positive impact to reliability, particularly for customers where electric service is more critical than for others. Such targeted load shedding could assist with the avoidance of larger, longer duration outages by initiating select, shorter duration outages. If implemented in a manner that is well-coordinated with existing emergency balancing schemes, this capability could benefit any electrical system reliability by avoiding underfrequency load shed (which sheds the customer load in its entirety) with the partial load-shed provided by the AMI or DR. There will be costs incurred to implement the schemes that would need to be weighed against the perceived value of the benefits associated with these technologies.

PUC-IR-12

How would the TOU rates and more robust demand response programs enabled by AMI facilitate additional renewable energy integration on each island?

Response:

Please see our response to PUC-IR-11.

PUC-IR-13

Would the TOU rates and more robust demand response programs enabled by AMI enable the FiT to allow sales by larger systems than those proposed by HECO and the Consumer Advocate? Please explain why or why not.

Response:

Time-of-use ("TOU") rates, demand response ("DR"), and other initiatives facilitated by an advanced metering infrastructure ("AMI") taken as a whole are unlikely to address all challenges facing the reliable integration of larger FIT-acquired generation resources. In particular, it is unlikely that distribution level voltage and power safety issues can be addressed through current state-of-the-art AMI initiatives given the speed of response that relay protection schemes require to effectively deal with faults with distribution interconnected generation. It is also very difficult for DR to be utilized for frequency regulation (second-to-second and minute-to-minute).

There are smart grid concepts being developed today to explore technology to provide high speed, high bandwidth communication between smart meters and other smart field devices to assist with distribution system protection and control. However, such concepts have yet to be proven in an operating environment and go far beyond today's AMI systems available for commercial use.

However, as mentioned in response to PUC-IR-11, TOU, DR, and other AMI facilitated initiatives could theoretically provide some positive benefits to address some of the challenges of integrating larger FIT-acquired systems, depending on the impacts expected for FIT additions. For example if TOU results in increasing off-peak loads then there could be a benefit by reducing the excess energy production during lower-load periods today. DR can be used to provide load reduction control capability which provides another tool in addition to fast-start units to balance generation during sustained ramping events due to loss of generation from variable sources (including those that may be acquired through a FIT) and potentially avoid balancing through the existing underfrequency load-shed scheme.

PUC-IR-14

Please describe all ways in which small-scale, biomass generators, including anaerobic digestion systems, do not meet the criteria listed on page 5 of the HECO and the Consumer Advocate's FiT proposal.

Response:

There are no small-scale (i.e., sub-1 MW) biomass generators currently operating on the HECO, HELCO, or MECO grid systems. At this time, HECO, HELCO, and MECO are not aware of any planned small-scale biomass generators.

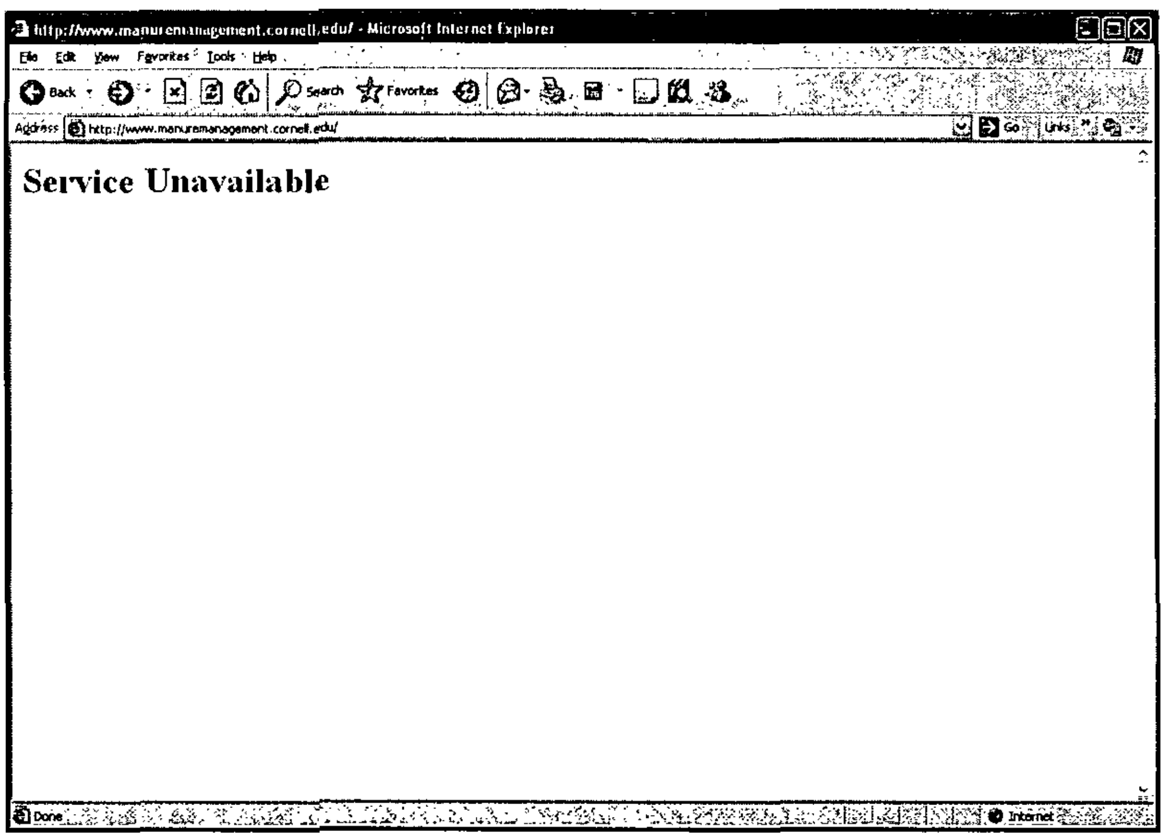
Biomass generators can differ in the resource/feedstock used (e.g., sewage sludge, animal waste, agricultural waste, municipal solid waste, etc.), the level of resource/feedstock processing required for conversion, the conversion technology utilized (e.g., anaerobic digestion, gasification, combustion, etc.), and the type of power generating equipment employed (e.g., internal combustion engine, combustion turbine, steam turbine, etc.). These differences can result in varying costs of generation, and as a result, the establishment of standardized energy payment rates and contractual terms to address these issues in a feed-in tariff would be difficult at best to determine.

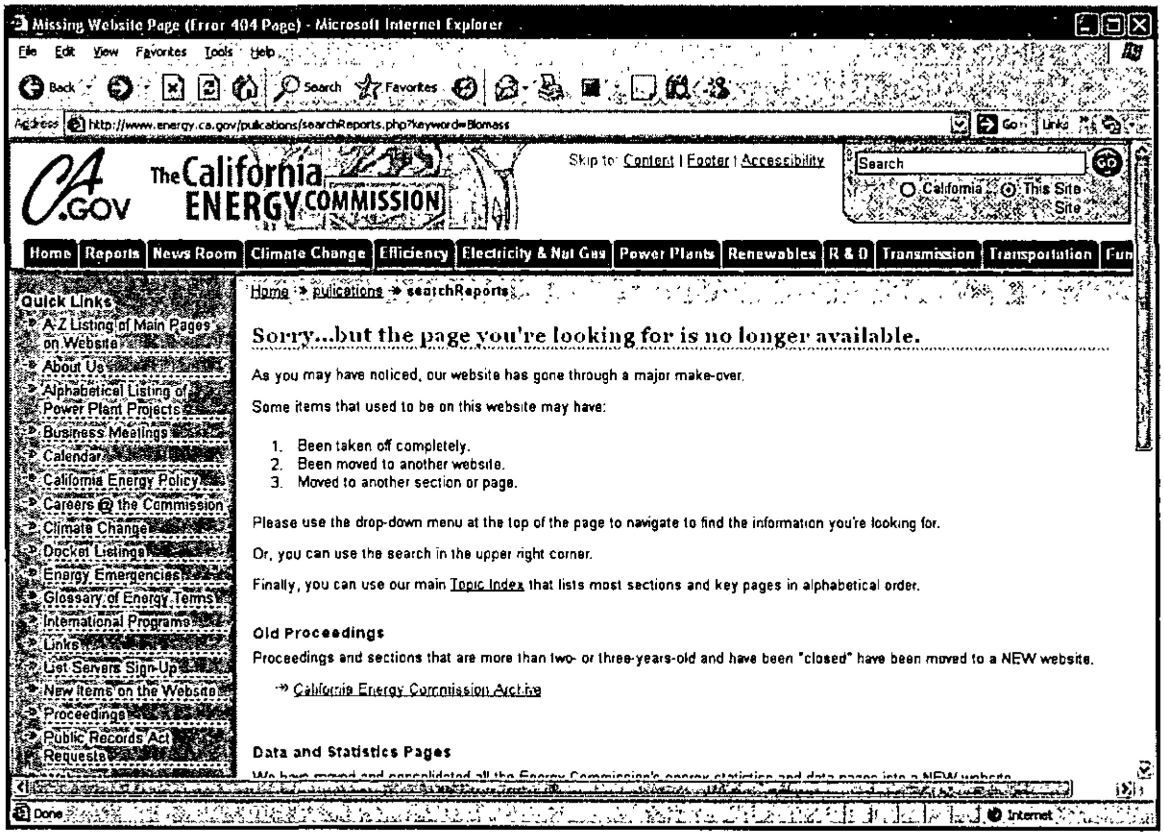
PUC-IR-15

According to HECO and the Consumer Advocate's response to HC&S-IR-l, "Biomass was not included in the initial list of FIT-eligible technologies since insufficient information was available on small scale biomass technology." Taking into consideration case studies and analysis provided by the Cornell University Manure Management Program (http://www.manuremanagement.comell.edu/) and reports conducted by or for the California Department of Energy (http://www.energy.ca.gov/publications/searchReports.php?keyword=Biomass), including the 2008 report, Cost of Electricity and Pipeline-Quality Natural Gas from Biogas (http://www.energy.ca.gov12008publications/CEC-999-2008-010/CEC-9992008-01O.PDF), what additional cost and performance information are necessary to include biomass resources in the FiT?

<u>Response:</u>

The websites cited were not available.





However, if we assume that these studies and reports describe projects that were developed in California and elsewhere on the mainland then additional information would be required to adjust their costs to make them comparable to Hawaii.

See also the response to PUC-IR-14.

PUC-IR-16

Please list and describe all grid-connected, biomass generators in Hawaii. For each, provide the capacity, feedstock, and location.

Response:

HPower is a waste-to-energy facility located in Kapolei on the island of Oahu. Developed to reduce the waste that goes into Oahu's landfill, HPower processes municipal solid waste into refuse derived fuel and burns the processed fuel to generate electricity. HPower sells up to 46 MW of power to HECO under a firm Power Purchase Agreement.

Hawaiian Commercial and Sugar Company (HC&S), located in Puunene on the Island of Maui, provides 12 MW of generation and an additional 4 MW of system protection capacity utilizing their internal automatic load shedding scheme for a total of 16 MW under a firm Power Purchase Agreement with MECO. HC&S utilizes bagasse (sugar cane residue), in addition to coal, oil, and recycled oil, in two steam units to generate electricity for both internal operations and export to MECO. HC&S also generates hydroelectric energy.

PUC-IR-17

Do biomass generators currently operating in Hawaii provide system reliability benefits, such as being utility dispatchable or curtailable, or having low-voltage/lowfrequency ride-through capabilities? Do sub-I MW biomass generators share these traits?

Response:

HPower and Hawaiian Commercial and Sugar Company (HC&S), as described in the response to PUC-IR-16, currently provide firm power under Power Purchase Agreements (PPA) to HECO and MECO, respectively. Similar to other firm power sources, these facilities provide system inertia and the ability to ride through system disturbances, which are important to maintaining grid stability. HPower is dispatchable under limited conditions for up to 46 MW. MECO dispatches up to 12 MW of HC&S generation at scheduled times and provides an additional 4 MW of System Protection Capacity utilizing their internal automatic load shedding scheme for a total of 16 MW.

There are no grid-connected sub-1 MW biomass generators currently operating on the HECO, HELCO, or MECO grid systems. Due to the size difference and the fact that HPower and HC&S also serve their own internal commercial load requirements, it is difficult to determine if sub-1 MW biomass generators would be capable of providing the same operating characteristics and benefits as these generators on a MW for MW basis. The ability of a sub-1 MW generator to ride through system disturbances will depend on the technology and equipment used at that facility.

PUC-IR-18

Please provide their locations, in-service dates, and size in kWs of all geothermal generators operating in Hawaii.

Response:

Puna Geothermal Venture (PGV), the only geothermal power plant in the State of Hawaii, is located in the Puna District on the island of Hawaii along the Lower East Rift Zone of Kilauea Volcano. The PGV power plant consists of ten generators, each with a rated capacity of 3,500 kW. The electricity generated is sold to HELCO under a Power Purchase Agreement. The PGV facility began service on June 26, 1993 (for 25,000 kW) then increased output to 30,000 kW in September 1996.

PUC-IR-19

Please describe all ways in which geothermal generators do not meet the criteria listed on page 5 of the HECO and the Consumer Advocate's FiT proposal.

Response:

FIT Criteria--(1) Do not require complex environmental and land use permitting which may impose significant uncertainties in project development timeframes and costs;

While geothermal energy has contributed to the energy mix since the early 1990s with a 30 MW power plant in the Puna district of the Big Island, its development in Hawaii was a long and difficult process.

The key aspects of geothermal regulation are related geothermal resource subzones, county geothermal resource permit, environmental review, drilling and power plant operations. Geothermal development can only take place in designated geothermal resource subzones. In the late 1980s, geothermal resource subzones were established through lengthy public processes on the Big Island and Maui. A total of 4 geothermal resource subzones were established: 3 subzones in the Kilauea East Rift Zone (Kilauea Middle East Rift Subzone, Kamaili Subzone and Kapoho Subzone) and one subzone on Maui on the Halelakala Southwest Rift Zone. The Department of Land and Natural Resources ("DLNR") under Chapter 184 (Designation and Regulation of Geothermal Resource Sub Zones) led the geothermal subzone process. If geothermal development is to take place in non-geothermal resource subzones, DLNR would have to initiate Chapter 184 proceedings with community, environmental, cultural, and other groups to establish a new geothermal resource subzone. Depending on the issues, this process could be lengthy with repeated initial and follow-up meetings.

Geothermal developers must also seek the County of Hawaii Rule 12 Geothermal Resource Permit approval (where geothermal development activities whether for research or commercialization purposes, means exploration, development or production of electrical energy from geothermal resources). This permit also includes meetings with community, environmental, cultural and other groups. Depending on the issues, this process could be lengthy also. Despite having a DLNR geothermal resource subzone designated on Maui, the County of Maui has yet to establish their geothermal resource permit rules and regulations. Thus any geothermal development on Maui will have to go through the administrative rule development of the county geothermal resource permitting process.

Environmental permits and review processes including HRS §343 environmental assessments and impact statements will also be needed as part of the various requirements by each jurisdiction. Other geothermal related permits will also be necessary for drilling, underground injection control, air quality and other activities.

Thus the time, resources and related costs required to seek and secure approvals for geothermal energy would not fit well into the proposed FIT program.

<u>FIT Criteria--(2) Do not typically, by virtue of their operating characteristics and size relative to the utility system, require extensive and lengthy interconnection studies or the need for significant interconnection requirements;</u>

The present 30 MW geothermal facility did require an extensive and lengthy interconnection requirement study which resulted in the installation of two separate 69 kV transmission lines from its Puna facility to Keaau (about 17 miles) to meet operational standards under various fault conditions. HECO is currently negotiating with the existing geothermal facility for an additional 8 MW at their Puna facility. This proposed increment is currently undergoing an interconnection requirements study.

Thus, depending on the size relative to the utility system, location and operating characteristics, geothermal projects will more than likely require an interconnection requirements study and could require significant transmission system additions.

<u>FIT Criteria--(3) Utilize technologies for which complex financial accounting issues relative to utility power purchase contracts have already been addressed.</u>

See DBEDT-IR-2 response on geothermal energy as it relates to complex financial accounting issues.

<u>FIT Criteria--(4) Have already been, or are currently in the process of being, implemented in Hawaii in commercial (non-R&D) application.</u>

A commercial 30 MW geothermal facility has been operating in the Puna District of the Big Island since the early 1990s.

PUC-IR-20

Do geothermal generators currently operating in Hawaii provide system reliability benefits, such as being utility dispatchable and curtailable or having low-voltage/lowfrequency ride-through capabilities?

Response:

The Puna Geothermal Venture facility on Hawaii Island is not under remote control by the HELCO system operator. Unlike energy from variable renewable resources (such as wind, run-of-river hydro, or PV) the output of the geothermal facility can be counted upon by the system operator for generating capacity and stable output. The facility typically operates to a schedule of 30 MW on-peak, and approximately 27 MW off-peak, though it can be curtailed below 27 down to 22 MW for excess energy curtailments, or dispatched to 30 during off-peak conditions at the request of the HELCO system operator. Change in MW output is accomplished by the local operator at Puna Geothermal Venture according to instructions via telephone contact by the HELCO system operator. The geothermal facility provides extended low-voltage and low-frequency ride-through commensurate with the conventional units on the HELCO system. The facility does not provide frequency control through local governor droop response or voltage regulation.

PUC-IR-21

Are there any installed wind turbines in Hawaii with less than 150 kW of capacity? If so, please describe their sizes in kWs, locations, total number, aggregate capacity, and installation years.

Response:

Wind turbines with rated capacity less than 150 kW are installed in the service territories of HECO, HELCO, and MECO. The wind turbines that are known to HECO, HELCO, and MECO to be in service are listed below.

Island of Oahu (HECO)

- One wind turbine has been installed under net energy metering (installation year in parenthesis): one 0.4-kW (2007) in Honolulu.

Big Island of Hawaii (HELCO)

- HELCO's Lalamilo wind farm consists of thirty-nine 17.5-kW and eighty-one 20-kW wind turbines (120 wind turbines in total) with an aggregate capacity of approximately 2,300 kW. The wind turbines were installed in 1985.

- Five 10-kW wind turbines with an aggregate capacity of 50 kW were installed at Parker Ranch in Waimea in 2000.

- Seventeen wind turbines with an aggregate capacity of 49.2 kW have been installed under net energy metering (installation year in parenthesis): one 1.8-kW (2008) and one 10-kW (2008) in Kamuela; one 1-kW (2006), two 1.8-kW (2008), one 1.9-kW (2008), and one 4.8-kW

(2009) in Kapa'au; one 1-kW (2006), six 1.8-kW (2008), one 1.9-kW (2008), one 2.4-kW (2009), and one 10-kW (2005) in Hawi.

Island of Maui (MECO)

- Six 1-kW wind turbines with an aggregate capacity of 6 kW were installed at the Maui Ocean Center in Maalaea in 2008.
- Two wind turbines with an aggregate capacity of 3.6 kW have been installed under net energy metering (installation year in parenthesis): one 1.8-kW (2008) and one 1.8-kW (2009) in Haiku.

PUC-IR-22

Do wind turbines currently operating in Hawaii provide system reliability benefits, such as being utility dispatchable or curtailable, or having low-voltage/low-frequency ride-through capabilities? Do small wind turbines share these traits?

Response:

None of the wind turbines in Hawaii can be considered dispatchable, in that they are dependent upon the wind as the primary energy source and cannot increase their output on demand. The contractual requirements for the larger wind plants are specified for the facility as a whole, and are addressed through a combination of turbine characteristics and other controls and equipment at the plant. The Kaheawa Wind Power plant on Maui island, Hawi Renewable Development plant on Hawaii island, and Pakini Nui plant on Hawaii island are able to limit the ramp rate (for increases and controlled decreases not the result of wind drop off) and provide curtailment control through use of plant control systems and turbine control capabilities. There are contractual requirements to limit the instantaneous change (1.2 MW/ 2 second scan) and average rate of second-to-second fluctuation; but for all facilities there have been occasions where the standards were exceeded. These facilities are also designed to remain connected to the system through disturbances as spelled out in under voltage and underfrequency ride-through requirements specified in the contract. The ride-through requirements are not as stringent as have typically been required of conventional units. However, the ride-through capabilities are designed to allow the wind plants to remain connected to the power system during typical faults and to coordinate with the underfrequency load-shedding schemes. These three wind plants also provide voltage regulation at the point of interconnection.

MECO currently has 3 small wind generators with less than 150kW capacity comprised of a 6kW turbine in Maalaea and two 1.8 kW turbines in Haiku. These generators are inverter based, non-dispatchable, and non-curtailable. They are installed with the standard UL 1741 trip settings – and thus do not remain connected through low frequency and voltage events.

PUC-IR-23

Please provide the capacity, location, and installation years of all in-line hydropower systems operating in Hawaii.

Response:

The County of Hawaii Department of Water Supply currently has two small hydro induction generators. The first is located at the Waimea Treatment Plant. This unit has a design capacity of 36kW and it was installed in June 1982. The second is Kaloko Tank 2, located on Hina Lani Street, Kailua-Kona, Hawaii. This unit has a design capacity of 50kW and it was installed in September 2008.

PUC-IR-24

Do in-line hydropower systems operating in Hawaii provide system reliability benefits, such as being utility curtail able or having low-voltage/low-frequency ridethrough capabilities? How do these traits vary by system size?

Response:

The in-line hydropower systems on the island of Hawaii do not provide these capabilities.

PUC-IR-25

In HECO and the Consumer Advocate's FiT proposal, HECO requested that 10% of the value of the utility's purchases under the FiT be placed into rate base.

(a) Please describe how HECO determined that 10% was the appropriate amount. Provide all supporting workpapers, calculations, and other analysis.
(b) Please explain legally, whether the proper proceeding to dispose of this question is the current proceeding or a rate case.
(c) Since "rate base" is defined as original cost of fixed investment less depreciation, please explain how including a non-investment purchase cost in rate base is (i) logical and (ii) lawful.
(d) If you determine that doing so is either illogical or unlawful, do you have in mind some other method of compensation?
(e) Do you agree that as a matter of arithmetic such compensation would allow HECO to recover from ratepayers an amount exceeding its actual cost, thus producing a return on equity exceeding the authorized return on equity?
(f) Assuming that the authorized return on equity reflected any risks associated with the purchase, precisely what is the cost-based rationale for the concept of recovering more than the actual cost of service in excess of the authorized return on equity?

Response:

(a) The provision that 10% of the value of the utility's purchase under the FIT be placed into rate base originated from the HCEI Agreement (item 7). As indicated in response to question 26 of Appendix C of the scoping paper entitled "Feed-In Tariffs: Best Design Focusing Hawaii's Investigation", the inclusion of a percentage of FIT energy purchases in rate base was proposed by other parties as part of the HCEI package.

(b) The appropriate proceeding to address this question is the FIT docket. The FIT docket deals specifically with FIT principle and policy issues, with a potential outcome being the establishment of a FIT. For example, the issues in this docket include what is the purpose of a FIT, and what is the best design for a FIT or alternative method. One subject to be addressed as part of the design of a FIT is whether 10% of the value of a utility's purchases under a FIT should be placed into rate base.

It is appropriate to address all of the FIT principle and policy questions in this FIT docket. Addressing one FIT principle and policy issue in a different proceeding, separate and apart from the other FIT principle and policy issues, would result in that question being addressed in a vacuum. This proposed feature of a FIT should be one of the features considered in total with all of the other features proposed for a FIT.

In contrast to this docket, a utility's rate case is an appropriate proceeding to implement policies and principles that result from this FIT proceeding. For example, depending on the outcome of the FIT docket, a rate case could include in a utility's rate base, a certain percentage of a utility's purchases under the FIT. The rate case can examine the amount of the utility's purchases that were made under the FIT that will be applied against a certain percentage; but the rate case should not examine what the percentage to be applied against those purchases under the FIT should be. Those types of policies and principles should be examined in total with all of the other FIT policies and principles.

(c) As explained, the proposal was made by other parties. HECO's understanding was that the proposal was intended as a means of restoring the financial profile of the utility to enable it to undertake the FIT.

(d) To the extent that FIT increases the utilities' risks, the increase in risk should be reflected in a higher allowed rate of return on equity.

(e) Theoretically, all other things being equal, recovery in excess of cost would result in return in excess of allowed return on equity, absent any adjustment to allow for such higher return.

(f) See response to (a) and (c) above.

PUC-IR-26

Please list and describe any mechanisms that European regulators have used to compensate utilities for the additional imputed debt and administrative costs associated with FiTs.

Response:

HECO is not aware of mechanisms that European regulators have used to compensate utilities for the additional imputed debt and administrative costs associated with FITs.

PUC-IR-27

Please list and describe any mechanisms that U.S. state or federal regulators have used to compensate utilities for the additional imputed debt and administrative costs associated with power purchase agreements.

Response:

HECO is not aware of mechanisms that U.S. state or federal regulators have used to compensate utilities for the additional imputed debt and administrative costs associated with FITs.

PUC-IR-28

According to HECO and the Consumer Advocate's response to Question 28 of Appendices A and C of the Feed-in Tariffs Investigation Scoping Paper:

"HECO proposes that in lieu of the utility earning any return on purchased power, the parties consider a FIT agreement which limits the utility's liability under the FIT agreement to the amount that the utility recovers in its rates. Under such a provision, HECO's payments to the customer-generator would be limited to the amounts recoverable in the purchased power (or other direct cost recovery) clause."

Please list and describe any instances where regulators in Europe or the United States have provided such cost recovery assurances to utilities for FiT or PPA purchases.

Response:

As discussed in the response to PUC-IR-26, European feed-in tariff laws are structured such that any incremental costs are recoverable from either the ratepayer or the taxpayer. In Spain and Germany, transmission system operators have a must take requirement for renewable electricity, and they also must pay legislatively established feed-in tariff rates. Costs for these purchases are then reallocated nationally through uplift charges levied by each distribution utility. Since this allocation mechanism is established under the law, the transmission utilities require no recovery assurances. In the Netherlands, by contrast, the government pays the feed-in tariff rates and so no utility cost recovery assurances are necessary.[1]

In the United States, such cost recovery assurances are generally not provided for PPA purchases[2] because PPAs – unlike European feed-in tariffs – are not accompanied by must-take requirements. Since under the proposed feed-in tariff, HECO would be offering standard offer contracts at prices established through regulation, the proposed liability limitation for renewable

[1] Ibid.
[2] Interviews with Regulatory Assistance Project staff and members of the KEMA project team

electricity purchases is a reasonable alternative to legislatively established cost recovery mechanisms.

PUC-IR-29

Please describe any system capacity or energy production size restrictions for systems seeking negotiated power purchase agreements with HECO, as described on page 10 of the KEMA attachment to HECO and the Consumer Advocate's FiT proposal.

Response:

The referenced section (§3.2.2 – Negotiated Power Purchase Agreements) states:

> Sale of as-available energy to the HECO Companies will not be required to be done via the FIT and may be contracted on a negotiated power purchase agreement basis, provided that the HECO Companies will not be required to offer pricing, terms, and conditions for such power purchase agreements that are the same as under the FIT, nor follow the same contract processing and technical review procedures established for the FIT. [footnote 8 omitted] In establishing the FIT pricing and program design, the HECO Companies will encourage development of eligible resources to come in via the FIT in pursuit of the policy objective of encouraging systematic development of renewable resources.

Currently, HECO is negotiating with renewable energy developers for several different projects for the provision of renewable energy to HECO on Oahu under power purchase agreements. Three of the projects are "grandfathered" under the Commission's Competitive Bidding Framework. Additional projects are on the short list of bidders who were selected after an initial evaluation of their proposals submitted in response to HECO's 100 MW Non-Firm Renewable Energy Request for Proposals ("RE RFP") in Docket No. 2007-0331. Also, HECO has received a proposal for a project whose size is below the threshold for competitive bidding.

The developers for the three grandfathered projects submitted unsolicited proposals before the Competitive Bidding Framework was established by the PUC in December 2006. The project sizes are approximately 6 MW, 30 MW and 100 MW.[1]

In HECO's 100 MW Non-Firm RE RFP, HECO stated that "Bidders should prepare

[1] For the 100 MW grandfathered project, the energy will be delivered on an as-available basis during Phase 1, and on a scheduled basis during Phase 2.

proposals for renewable energy contracts between 5 MW and no larger than 100 MW."[2] The 100 MW upper bound was established because it was determined through a qualitative assessment that that was the amount of variable generation that the system could accept in its current state.[3] The projects under consideration from the RE RFP are all within this range.

HECO may also file an application for waiver from competitive bidding requirements in 2009 to negotiate a contract for additional energy and capacity from an expansion of the City & County of Honolulu's H-Power facility.

Project size restrictions may be determined from the Interconnection Requirements Studies that are in progress to identify the transmission system infrastructure that will need to be installed to integrate each of the proposed projects into the HECO grid. For example, if a generating resource is installed at the end of a radial transmission line, the size of the project may need to be limited to prevent voltages or currents from exceeding safe or statutory limits.

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[2] Section 2.7, page 11, of the RE RFP, dated June 2008.

[3] Section A, page 3, of the Solicitation of Interest for Non-Firm Renewable Energy Projects, dated September 28, 2007 stated, "The proposed scope takes into account (1) the expectation that up to 60 MW of non-firm renewable energy may be acquired on the HECO system through power purchase agreements with developers of proposed projects that are exempt from the Framework (hereafter referred to as "grandfathered proposals"), (2) the infrastructure available to bring these resources on-line in a timely manner (i.e., the amount of additional non-firm energy that can be accepted without significant, time-consuming transmission or sub-transmission system improvements), (3) operational and reliability issues associated with incorporating relatively large amounts of intermittent non-dispatchable generation into our system, (4) the need to prudently manage the acquisition of these non-firm intermittent resources in an incremental manner to gain critical operational experience and pending further system analyses, so as not to inadvertently foreclose future opportunities to add more renewable resources, and (5) the desire to follow a responsible and systematic approach toward meeting HECO's RPS requirement.."

PUC-IR-30

Are there currently or could there be under HECO and the Consumer Advocate's proposed FiT, any renewable energy systems whose size renders them ineligible all of the following: HECO's proposed FiT, negotiated power purchase agreements, and the framework for competitive bidding?

Response:

No. Negotiated purchase power agreements are available to projects of all sizes. One of the design objectives of the proposed FIT was to "complement existing Hawaii policy framework as much as possible and target gaps in the current renewable energy policy framework." (KEMA Report, page 9)

The Framework for Competitive Bidding will remain unchanged. The targeted project sizes of the FIT Proposal are less than the minimum project size thresholds set for competitive bidding. (Joint Proposal, page 16) The combination of Feed-in Tariff, Purchase Power Agreements and Competitive Bidding is designed to accommodate renewable generation projects of any size.

PUC-IR-31

Under HECO and the Consumer Advocate's proposed FiT, could distributed renewable energy systems not included in the initial list of eligible FiT technologies apply for net metering? If not, through what mechanism could they sell power to HECO or otherwise receive compensation or credit for power production?

Response:

Net energy metering is available to permanent customers who own (or lease from a third party) and operate (or contract to operate with a third party) a solar, wind turbine, biomass, or hydroelectric energy generating facility, or a hybrid system consisting of two or more of these facilities, with a capacity of not more than one hundred kilowatts (100 kW). (Rule No. 18 Net Energy Metering part A)

The proposed FIT does not presently include biomass and hybrid technologies in the initial list of FIT eligible technologies. Technologies that are eligible for NEM but not the FIT will be allowed to apply for NEM until an appropriate FIT for that technology is available.

Renewable energy systems under the Competitive Bidding threshold may negotiate a power purchase agreement with the utility. See the response to PUC-IR-30.

PUC-IR-33

According to page 12 ofHECO and the Consumer Advocate's FiT proposal: "Furthermore, the HECO Companies and the Consumer Advocate agree that tariff pricing should differentiate between technology type, project size, and location, and should be based on the costs of developing a 'typical' project that is reasonably cost-effective."

According to page 13 ofHECO and the Consumer Advocate's FiT proposal:

> "A base tariff rate by technology will be paid to generation projects that provide system reliability benefits such as being utility dispatchable or curtailable, or have low-voltage/low-frequency ride-through capabilities. The base FIT will be adjusted downwards for renewable energy systems that do not have these features, if allowable from a system integration perspective."

According to page 2 of the KEMA report attached to HECO and the Consumer Advocate's FiT proposal, "By basing incentive levels on the cost of generation plus a reasonable return, FITs create a high degree of investor security."

a. Based on these statements, it appears that HECO and the Consumer Advocate support crafting FiTs to compensate developers for the typical costs to develop each of the renewable energy technologies in Hawaii and provide a reasonable rate of return. Further, the compensation from this base level will be reduced for technologies that are not curtailable or dispatchable and do not feature low-voltage/low frequencies ride-through capability. It appears, that absent other measures, the downwardly-adjusted FiTs may be insufficient to compensate developers for the typical costs and provide a reasonable return for certain renewable energy technologies. Do you agree that this could be the case? Please explain why or why not.

b. Will the initial FiT price levels be created with the assumption that the compensation will be reduced based on lack of these features? Restated, would initial FiT prices compensate for the reduction described in the first quote to ensure that such technologies are still viable?

<u>Response:</u>

a. The feed-in tariff values contained in Table 3-1 on p. 23 are hypothetical, and are intended as illustrative. As noted, the feed-in tariff values for systems that are curtailable and have ride-through capability are higher than those without those capabilities. In each circumstance, however, it is intended that the feed-in tariff rates will be based on generation cost plus a reasonable return. For generators that can provide system reliability benefits, the higher feed-in tariff rates reflect the higher cost of adding those capabilities. Systems that do not invest in curtailability and/or low-voltage/low-frequency ride through capability have lower generation costs and therefore would require lower feed-in tariff rates. HECO would like to prioritize the development of generators that support system reliability, but this prioritization is primarily reflected in higher proposed annual quantity targets.

b. As described in 33.a. above, the rates for each generator should be set based on generation cost, plus a reasonable profit, such that generators both with and without "grid-friendly" capabilities can be viably developed.

PUC-IR-34

In part A of DBEDT-IR-7, the Department of Business, Economic Development, and Tourism asked HECO and the Consumer Advocate how much of the total renewable resource commitments under the Energy Agreement HECO plans to purchase via the FiT. HECO and the Consumer Advocate's response claimed that such resources would be used "to the degree possible." The response also described 140MW of PV to be contracted using negotiated power purchase agreements or the FiT as well as 127 MW of PV to be developed under net energy metering, which would be replaced by the FiT. Please also provide the total amount of renewable resources that HECO anticipates or seeks to elicit through its proposed FiT and the amount of capacity that HECO anticipates or seeks to elicit through its proposed FiT from each applicable technology. Provide this information in a table showing how much of each technology and size tier proposed in HECO's FiT proposal will likely be incorporated into the system during each year for each island.

Response:

The HECO Companies have not yet determined technology specific annual FIT targets for each island for each year, given the numerous factors to consider in setting annual FIT targets described in Section 3.6 of the KEMA report. However, in considering the Commission's information request, the HECO Companies could envision that at least for the initial two years of the FIT, annual FIT targets could be set for each eligible technology type primarily based on (1) providing reasonable opportunity to the market, including accommodation of at least the amount of historical net energy metering activity , (2) providing enough of an experience base to allow the first FIT update to be done in an informed fashion, and (3) being administratively manageable to the utility, the Consumer Advocate, and the Public Utilities Commission given the ramping up of a new program involving numerous contracting processes, interconnection reviews, and management of power purchase payments. As an example, based on the FIT project sizes proposed by the HECO Companies and the Consumer Advocate in the December 23, 2008 filing, and based on 2008 executed net energy metering agreements on Oahu of just under 400 kW of PV less than or equal to 10 kW and just under 2 MW of PV greater than 10 kW and up to 100 kW, annual targets for Oahu in the initial two years could be as follows:

Oahu	Year 1	Year 2	Number of Projects
PV less than or equal to 10 kW	750 kW	750 kW	75 minimum
PV greater than 10 kW and less than or equal to 100 kW	2,500 kW	2,500 kW	25-250
PV greater than 100 kW and less than or equal to 500 kW	5,000 kW	5,000 kW	10-50
Concentrated Solar Power up to 500 kW	2,500 kW	2,500 kW	5 minimum
Wind up to 100 kW	500 kW	500 kW	5 minimum
In-Line Hydro up to 100 kW	500 kW	500 kW	5 minimum

The annual capacity targets for CSP, wind, and in-line hydro would be driven primarily by the number of targeted projects.

PUC-IR-35

Have HECO or the Consumer Advocate considered giving priority in the FiT queue, as described on page 33 of the KEMA report attached to HECO and the Consumer Advocate's FiT proposal, to projects that provide system reliability benefits, such as being utility dispatchable or curtailable, or having low-voltage/low-frequency ridethrough capabilities? How might such a policy encourage or hasten the development of renewable energy projects that enhance system reliability?

Response:

As described in the KEMA report, the FIT should differentiate between technology types and the attributes they provide, with priority given to resources that are "grid friendly." First, annual FIT targets should be structured to place priority on resources that provide system reliability benefits. For example, a greater amount of capacity from such projects could be targeted in the FIT program structure compared to projects without such attributes. In certain cases, projects without certain grid friendly attributes may not even be eligible for the FIT. Within each category of FIT resources, a queue could then be established. In this manner, the entire FIT program, including the queuing system, encourages development of projects that enhance system reliability.